

CLAIMS:

1. A method of compensating dispersion of a communications signal conveyed through an optical communications system, the method comprising steps of:

deriving a compensation function that substantially mitigates the dispersion imparted to the communications signal by the optical communications system;

processing an electrical input signal using the compensation function to generate a predistorted electrical signal; and

modulating an optical signal using the predistorted electrical signal to generate a corresponding predistorted optical signal for transmission through the optical communications system.
2. A method as claimed in claim 1, wherein the step of determining a compensation function comprises steps of:

measuring a performance parameter related to the optical dispersion; and

calculating respective values of one or more parameters of the compensation function that optimizes the measured performance parameter.
3. A method as claimed in claim 2, wherein the step of measuring the performance parameter comprises a step of measuring any one or more of:

- 29 -

net chromatic dispersion at one or more wavelengths;
a bit error rate;
a signal-to-noise ratio; and
an eye-opening ratio.

4. A method as claimed in claim 2, wherein the step of measuring the performance parameter comprises steps of:

sampling the optical signal received through the optical communications system; and
calculating an error function indicative of a difference between the sampled optical signal and a predetermined reference.

5. A method as claimed in claim 1, wherein the step of processing the electrical input signal comprises a step of digitally filtering the electrical input signal using any one of:

a Fast Fourier Transform (FFT) filter;
a Finite Impulse Response (FIR) filter; and
a Infinite Impulse Response (IIR) filter.

6. A method as claimed in claim 1, wherein the step of processing the electrical input signal comprises steps of:

calculating successive digital sample values of the predistorted signal, based on the electrical input signal and the compensation function; and

- 30 -

converting each successive sample value into a corresponding analog level of the predistorted electrical signal.

7. A method as claimed in claim 6, wherein the predistorted electrical signal comprises two or more orthogonal signal components, and the step of calculating successive digital sample values comprises a step of calculating successive corresponding sample values of each signal component.
8. A method as claimed in claim 7, wherein the orthogonal signal components comprise any one of:
In-phase and Quadrature signal components;
Amplitude and Phase signal components; and
Amplitude and frequency signal components;
9. A method as claimed in claim 6, wherein the electrical input signal comprises a substantially undistorted binary signal, and wherein the step of calculating successive digital sample values of the predistorted electrical signal comprises steps of:
calculating at least one respective sample value of the predistorted signal corresponding to each one of a set of predetermined N-bit words;
storing each calculated sample value in a look-up table; and
extracting a plurality of successive sample values of the predistorted electrical signal from the look-up table using the binary signal.

- 31 -

10. A method as claimed in claim 9, wherein the set of predetermined N-bit words encompasses all possible sequences of N-bits.
11. A method as claimed in claim 9, wherein the step of extracting a plurality of successive sample values of the predistorted electrical signal comprises steps of:
converting the electrical input signal into a series of N-bit words;
using each N-bit word as an index value to access a respective register of the look-up table; and
latching each sample value stored in the accessed register out of the look-up table.
12. A method as claimed in claim 9, wherein the number (N) of bits within each word is based on any one or more of:
an expected maximum dispersion of the optical communications system; and
an expected response time of the look-up table.
13. A method as claimed in claim 9, wherein the steps of calculating respective sample values of the predistorted electrical signal and storing the calculated numerical values in a look-up table are repeated at predetermined intervals.
14. A dispersion compensation system for compensating optical dispersion of a communications signal

- 32 -

conveyed through an optical communications system, the dispersion compensation system comprising:

derivation means for deriving a compensation function that substantially mitigates the dispersion imparted to the communications signal by the optical communications system;

a compensation processor for processing an electrical input signal using the compensation function to generate a predistorted electrical signal; and

modulating means for generating a predistorted optical signal for transmission through the optical communications system, based on the predistorted electrical signal.

15. A system as claimed in claim 14, wherein the derivation means is implemented remote from the compensation processor.

16. A system as claimed in claim 14, wherein the derivation means comprises:

a detector for measuring a performance parameter related to the optical dispersion; and

a calculation engine for calculating respective values of one or more parameters of the compensation function that optimizes the measured performance parameter.

17. A system as claimed in claim 16, wherein the detector is adapted to measure any one or more of:

net chromatic dispersion at one or more wavelengths;

- 33 -

a bit error rate;
a signal-to-noise ratio; and
an eye-opening ratio.

18. A system as claimed in claim 16, wherein the detector is adapted to:

sample the optical signal received through the optical communications system; and
calculate an error function indicative of a difference between the sampled optical signal and a predetermined reference.

19. A system as claimed in claim 14, wherein the compensation processor comprises:

a digital filter for calculating successive digital sample values of the predistorted electrical signal, based on the electrical input signal and the compensation function; and

a digital-to-analog converter (DAC) for converting each successive digital sample value into a corresponding analog level of the predistorted electrical signal.

20. A system as claimed in claim 19, wherein the digital filter comprises any one of:

a Fast Fourier Transform (FFT) filter;
a Finite Impulse Response (FIR) filter; and
a Infinite Impulse Response (IIR) filter.

- 34 -

21. A system as claimed in claim 19, wherein the predistorted electrical signal comprises two or more signal components, at least one component being at least partially orthogonal to at least one other component.
22. A system as claimed in claim 21, wherein the orthogonal signal components comprise any one of:
In-phase and Quadrature signal components;
Amplitude and Phase signal components; and
Amplitude and frequency signal components;
23. A system as claimed in claim 21, wherein the digital filter comprises either one of:
a respective digital filter for generating each component; and
a single digital filter adapted to substantially simultaneously output a respective digital sample value for each component.
24. A system as claimed in claim 21, further comprising, for each component of the predistorted electrical signal, a respective second digital filter operatively coupled for imposing a predetermined delay.
25. A system as claimed in claim 24, wherein the respective predetermined delay imposed on each component is selected to compensate a differential propagation delay across all of the components of the predistorted electrical signal.

- 35 -

26. A system as claimed in claim 19, wherein the digital filter comprises:
- a serial-to-parallel converter for converting the binary signal into a series of N-bit words; and
 - a Random Access Memory (RAM) Look-up table (LUT) for outputting at least one digital sample value of the predistorted electrical signal corresponding to each N-bit word.
27. A system as claimed in claim 26, wherein the look-up table comprises:
- two or more memory blocks for storing a respective portion of each digital sample value of the predistorted signal; and
 - a summation circuit for summing the respective portions of the digital sample value output from each memory block.
28. A system as claimed in claim 26, wherein the number (N) of bits within each word is based on any one or more of:
- an expected maximum dispersion of the optical communications system; and
 - an expected response time of the look-up-table.
29. A system as claimed in claim 14, wherein the modulating means comprises any one or more of:
- a narrowband laser adapted to generate the optical signal having a frequency which is controllable

- 36 -

in response to an analog current level of the predistorted electrical signal;

an optical modulator adapted to modulate either one or both of an amplitude and phase of the optical signal in response to an analog voltage level of the predistorted electrical signal; and

a variable optical attenuator adapted to modulate an amplitude of the optical signal in response to an analog voltage level of the predistorted electrical signal.

30. A system as claimed in claim 19, wherein the compensation processor further comprises a non-linear compensation means for adjusting each digital sample value of the predistorted electrical signal to compensate a nonlinear performance of at least the modulation means.

31. A system as claimed in claim 30, wherein the non-linear compensation means comprises:

a non-linear processor for calculating a mapping between each sample value and a corresponding adjusted sample value; and

a non-linear compensator operatively coupled to an output of the digital filter for applying the mapping to each digital sample value of the predistorted electrical signal.

32. A system as claimed in claim 31, wherein the non-linear compensator comprises a Random Access Memory (RAM) Look-up table (LUT) for outputting an adjusted

- 37 -

digital sample value corresponding to each digital sample value of the predistorted electrical signal generated by the digital filter.

33. A system as claimed in claim 30, wherein the digital filter is a Random Access Memory (RAM) Look-up table (LUT) adapted to store a plurality of predetermined digital sample values of the predistorted electrical signal, and wherein the non-linear compensation means comprises:

a non-linear processor for calculating a mapping between each sample value and a corresponding adjusted sample value; and

means for adjusting each of the predetermined digital sample values stored in the RAM LUT in accordance with the calculated mapping.

34. A dispersion compensator for compensating optical dispersion of a communications signal conveyed through an optical communications system, the dispersion compensator being implemented in a transmitter of the optical communications system, and comprising:

a digital filter for calculating successive digital sample values of the predistorted electrical signal, based on the electrical input signal and the compensation function; and

a digital-to-analog converter (DAC) for converting each successive digital sample value into a corresponding analog level of the predistorted electrical signal for driving an optical

- 38 -

modulation means so as to generate a corresponding predistorted optical signal for transmission through the optical communications system.

35. A dispersion compensator as claimed in claim 34, wherein the digital filter comprises any one of:

a Fast Fourier Transform (FFT) filter;
a Finite Impulse Response (FIR) filter; and
a Infinite Impulse Response (IIR) filter.

36. A dispersion compensator as claimed in claim 34, wherein the predistorted electrical signal comprises two or more orthogonal signal components.

37. A dispersion compensator as claimed in claim 36, wherein the orthogonal signal components comprise any one of:

In-phase and Quadrature signal components;
Amplitude and Phase signal components; and
Amplitude and frequency signal components;

38. A dispersion compensator as claimed in claim 36, wherein the digital filter comprises either one of:

a respective digital filter for generating each component; and
a single digital filter adapted to substantially simultaneously output a respective digital sample value for each component.

- 39 -

39. A dispersion compensator as claimed in claim 36, further comprising, for each component of the predistorted electrical signal, a respective second digital filter operatively coupled for imposing a predetermined delay.
40. A dispersion compensator as claimed in claim 39, wherein the respective predetermined delay imposed on each component is selected to compensate a differential propagation delay across all of the components of the predistorted electrical signal.
41. A dispersion compensator as claimed in claim 34, wherein the digital filter comprises:
- a serial-to-parallel converter for converting the binary signal into a series of N-bit words; and
 - a Random Access Memory (RAM) Look-up table (LUT) for outputting at least one digital sample value of the predistorted electrical signal corresponding to each N-bit word.
42. A dispersion compensator as claimed in claim 41, wherein the look-up table comprises:
- two or more memory blocks for storing a respective portion of each digital sample value of the predistorted signal; and
 - a summation circuit for summing the respective portions of the digital sample value output from each memory block.

- 40 -

43. A dispersion compensator as claimed in claim 41, wherein the number (N) of bits within each word is based on any one or more of:
- an expected maximum dispersion of the optical communications system; and
 - an expected response time of the look-up-table.
44. A dispersion compensator as claimed in claim 34, wherein the optical modulation means comprises any one or more of:
- a narrowband laser adapted to generate the optical signal having a frequency which is controllable in response to an analog current level of the predistorted electrical signal;
 - an optical modulator adapted to modulate either one or both of an amplitude and phase of the optical signal in response to an analog voltage level of the predistorted electrical signal; and
 - a variable optical attenuator adapted to modulate an amplitude of the optical signal in response to an analog voltage level of the predistorted electrical signal.
45. A dispersion compensator as claimed in claim 34, wherein the compensation processor further comprises a non-linear compensation means for adjusting each digital sample value of the predistorted electrical signal to compensate a nonlinear performance of at least the modulation means.

- 41 -

46. A dispersion compensator as claimed in claim 45, wherein the non-linear compensation means comprises:
- a non-linear processor for calculating a mapping between each sample value and a corresponding adjusted sample value; and
 - a non-linear compensator operatively coupled to an output of the digital filter for applying the mapping to each digital sample value of the predistorted electrical signal.
47. A dispersion compensator as claimed in claim 46, wherein the non-linear compensator comprises a Random Access Memory (RAM) Look-up table (LUT) for outputting an adjusted digital sample value corresponding to each digital sample value of the predistorted electrical signal generated by the digital filter.
48. A dispersion compensator as claimed in claim 45, wherein the digital filter is a Random Access Memory (RAM) Look-up table (LUT) adapted to store a plurality of predetermined digital sample values of the predistorted electrical signal, and wherein the non-linear compensation means comprises:
- a non-linear processor for calculating a mapping between each sample value and a corresponding adjusted sample value; and
 - means for adjusting each of the predetermined digital sample values stored in the RAM LUT in accordance with the calculated mapping.